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Day Time Wheel Running Activity in Laboratory Rats Following Geomagnetic Event of 5-6 July 1974

by

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ABSTRACT.- Albino laboratory rats that were given free access to running wheels while maintained on a 12:12 h L:D schedule were observed to display marked increases in day cycle activity following an unusually intense geomagnetic storm. The activity changes were not immediate but peaked one day to several days after the storm. Two less intense geomagnetic storm conditions during the 51 day observation period were associated with less marked activity increases. Ambient room temperature fluctuations were not significantly correlated with either geomagnetic activity or day cycle activity measures.

INTRODUCTION

Several authors have reported direct or lagged correlations between fluctuations in geomagnetic activity and animal behaviour (e.g., Friedman, Becker and Bachman, 1965; Lindauer and Martin, 1968; Persinger, 1975; Southern, 1971). Although these effects are persistent they are usually quite weak and seem to reflect low-level fluctuations within the organism's stability limits. Control systems theory indicates that a sufficiently intense sudden input change may induce long-lived instabilities and new adjustment levels before homeostasis is restored. Extraordinary geomagnetic storms theoretically would have the capability to induce such instabilities. Very intense geomagnetic perturbations are rare and planned experiments to measure behavioural concomitants involve obvious difficulties. However, during a routine test series in the summer of 1974, an unusually intense storm condition did occur. The observations recorded are reported in this paper.

METHOD

Five male, 120-day old Wistar strain albino rats were placed in separate Lafayette Company 35 cm diameter running wheel apparatus situated in a windowless room. Continuous free access to the running wheel was maintained throughout the experiment for each subject. As soon as the subjects had adjusted to the 12:12 h L:D cycle, as defined by less than 5 rev/12 h during the light period for one week, measurements were started (12 June 1974). The total number of wheel revolutions displayed by each subject during the dark cycle and the light cycle (local noon to local midnight) were recorded daily until the end of the experiment (1 August 1974). During the experiment all subjects received food and water ad libitum. (Since this experiment was also a pilot test in a series of studies with amino acid effects, two of the subjects received 0.9% taurine drinking solutions. However, this treatment did not influence the behaviour measured).

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Fresh drinking solutions were given at the end of the night cycle each day during which time checks were made to insure proper functioning of the running wheels; the latter operation was completed with minimum disturbance to the subjects. Defecation trays were changed once a week at this time. Ambient temperature, maintained by a homeostat, was recorded twice daily and averaged 23 $\pm$ 2°C. Light intensities within the wheels averaged 80 lx and originated from overhead fluorescent lamps. Although only the experimenter entered the room for daily measurements, a circulation fan was used as masking noise (50 db) against possible extraneous sounds from human activity. A RFL Industries Gaussmeter (Model 750) demonstrated that the 'normal' background static geomagnetic field averaged 0.66 $\pm$ 0.01 gauss.

RESULTS AND DISCUSSION

Daily changes in the Fredericksburg geomagnetic A indices and the day time running activity (number of wheel revolutions) for the 5 subjects (A to E) between 12 June and 1 August 1974, are shown in Fig. 1.

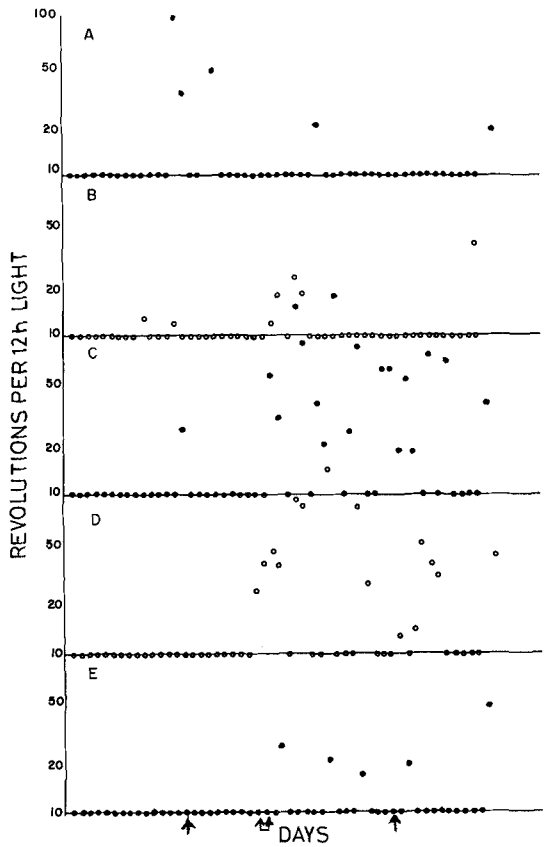

Fig. 1. Revolutions/12 h in daily light periods for 5 different animals (A, B, C, D, E) during two 'normal' magnetic storms (single arrows) and the intense geomagnetic disturbances of 5-6 July 1974 (double arrow).

Day cycle activity is presented since running wheel activity in this period was unusual; almost all activity was confined typically to the dark period in the 12:12 h L:D cycle described. Figure 1 shows an increase in day time running behaviour for animals A, B and C on the day of a 'normal' magnetic storm during 26-27 June (first single arrow). Interestingly, subjects A and B displayed increased day time activity on the day before the storm. After this storm, none of the subjects (except for one day in subject A's record), displayed any day time activity until the beginning of the unusually intense event of 5-6 July 1974 (double arrows). The peak of the storm was associated with an A index value of 113. Subject D showed increased activity on the days of the storm while all other subjects displayed the increased day activity 1-7 days after the storm commencement. About 19 July, the subjects began to return to baseline values, but on 23 July another, less intense magnetic storm occurred (second single arrow). This time subject D exhibited a resumed increase in day activity; although, subjects C and E also displayed increased activities during this period, they appear to be associated with the previous activity trains. There were no significant correlations between the geomagnetic indices and ambient room temperature ($r = -0.15$, $df = 49$, $p > 0.10$) nor between room temperature and the number of wheel revolutions/12 h (day time) displayed by the subjects ($r = \pm 0.10$). Night time activity 400 to 900 rev/12 h) was consistent within subjects and did not reflect the marked geomagnetic storm-associated fluctuations observed for the day time activity. These observations are compatable with the hypothesis that intense geomagnetic field disturbances may interfere with biological homeostasis by interfering with (e.g., masking) normal low level zeitgebers and consequently contributing to 'desynchronization' of an organisms' time-varying activities (Persinger, 1974). Using an elementary control systems approach, one of the methods employed to describe homeostatic systems, a number of commensurate patterns in the subjects' activity patterns (Fig. 1) were noted:
(1) the more intense the geomagnetic 'impulse', the greater the response in the biological systems (subjects), (2) the more intense the 'impulse', the longer the post-impulse deviations, (3) less dampened systems (those that displayed the greatest initial sensitivity to the intense impulse) required longer durations to habituate (e.g., animals C and D), (4) dampened systems (e.g. animal E) displayed less response sensitivity, (5) systems that had responded most recently, required a longer latency to respond again.

In light of the recent work by Gough and Camfield (1972) and Porath and Dziewonski (1971), the generality of the observed behavioural-geomagnetic effects may be restrictive. These experimenters have reported that intense geomagnetic variation (and period-dependent) anomalies can be induced in conductive geological structures, e.g., low resistivity sedimentary basins. Some of these anomalies can display transient horizontal field values of more than twice the normal level. Since the Sudbury region is typified by abnormal conductivities associated with sub-surface mineral deposits, localized storm conditions may have facilitated the observed effects.

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